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Removal Of Salt And Pepper Noise Using Advanced Modified Decision Based Unsymmetric Trimmed Median Filter In Colour And Gray Scale Images

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Abstract:- **An improved decision-based algorithm for the restoration of gray-scale and colour images that are highly corrupted by Salt-and-Pepper noise, is proposed in this paper which efficiently removes the salt and pepper noise while preserving the details in colour images using Iterative Modified Decision based Unsymmetric Trimmed Median Filter. The performance of the proposed method is analyzed by using various qualities of metrics, such as Mean Square Error (MSE) and Peak Signal to Noise ratio (PSNR). Simulation results clearly show that the proposed method is out performs both in qualitative as well quantitative fidelity criteria, when it is compared with MDBUTMF.**

Index Terms- **Image; Impulse Noise; Median Jilter; Noise Density;**

I. INTRODUCTION

Image noise is random (not present in the object imaged) variation of brightness or colour information in images, and is usually an aspect of electronic noise. It can be produced by the sensor and circuitry of a scanner or digital camera. Image noise can also originate in film grain and in the unavoidable shot noise of an ideal photon detector. Image noise is an undesirable by-product of image capture that adds spurious and extraneous information.

The original meaning of "noise" was and remains "unwanted signal"; unwanted electrical fluctuations in signals received by AM radios caused audible acoustic noise ("static"). By analogy unwanted electrical fluctuations themselves came to be known as "noise".[1] Image noise is, of course, inaudible.[2]

The magnitude of image noise can range from almost imperceptible specks on a digital photograph taken in good light, to optical and radio astronomical images that are almost entirely noise, from which a small amount of information can be derived by sophisticated processing (a noise level that would be totally unacceptable in a photograph since it would be impossible to determine even what the subject was).

Fat-tail distributed or "impulsive" noise is sometimes called salt-and-pepper noise or spike noise.[7] An image containing salt-and-pepper noise will have dark pixels in bright regions and bright pixels in dark regions.[8] This type of noise can be caused by analog-to-digital converter errors, bit errors in transmission, etc.[9][10] It can be mostly eliminated by using dark frame subtraction, median filtering and interpolating around dark/bright pixels.

An image is a picture, photograph or any other form of 2D representation of any scene.[21] Most algorithms for converting image sensor data to an image, whether in-camera or on a computer, involve some form of noise reduction. There are many procedures for this, but all attempt to determine whether the actual differences in pixel values constitute noise or real photographic detail, and average out the former while attempting to preserve the latter. However, no algorithm can make this judgment perfectly, so there is often a tradeoff made between noise removal and preservation of fine, low-contrast detail that may have characteristics similar to noise. Many cameras have settings to control the aggressiveness of the in-camera noise reduction.

A simplified example of the impossibility of unambiguous noise reduction: an area of uniform red in an image might have a very small black part. If this is a single pixel, it is likely (but not certain) to be spurious and noise; if it covers a few pixels in an absolutely regular shape, it may be a defect in a group of pixels in the image-taking sensor (spurious and unwanted, but not strictly noise); if it is irregular, it may be more likely to be a true feature of the image. But a definitive answer is not available.

This decision can be assisted by knowing the characteristics of the source image and of human vision. Most noise reduction algorithms perform much more aggressive chroma noise reduction, since there is little important fine chroma detail that one risks losing. Furthermore, many people find luminance noise less objectionable to the eye, since

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its textured appearance mimics the appearance of film grain.

II. LITERATURE SURVEY

The high sensitivity image quality of a given camera (or RAW development workflow) may depend greatly on the quality of the algorithm used for noise reduction. Since noise levels increase as ISO sensitivity is increased, most camera manufacturers increase the noise reduction aggressiveness automatically at higher sensitivities. This leads to a breakdown of image quality at higher sensitivities in two ways: noise levels increase and fine detail is smoothed out by the more aggressive noise reduction.

For this, various filtering techniques were proposed to remove the impulse noise, but most popular filtering technique used is Median filter. There are many variants in median filter such as Standard Median Filter (MF), Adaptive Median Filter (AMF), Adaptive Weighted Algorithm (A WA), Switching Median Filter (SMF), Decision Based Algorithm (DBA), Decision Based Unsymmetric Trimmed Median Filter (DBUTMF) and Modified Decision Based Unsymmetric Trimmed Median Filter (MDBUTMF). The drawback of standard Median Filter (MF) [1] is that it is effective when the noise density is below 20%, if it is more than 20% the edge as well the image details are lost. Adaptive Median Filter (AMF) [2] gives better performance at low noise densities. At high noise densities the window size has to be increased which effects the burring of the image. In Switching Median Filter (SMF) [3], [4] the decision is based on a pre-defined threshold value. The drawback of this method is that defining robust decision is difficult. This drawback can be reduced by using Decision Based Algorithm (DBA) [5]. In this method for denoising the image a 3X3window size is used. If the processing pixel value is either 0 or 255 then the pixel is processed, else it is left unchanged. At high noise density the median value will be 0 or 255, which are noisy, in such a case, noisy pixels are replaced with neighboring pixels. The repeated replacement of neighboring pixel causes streaking effect. This drawback is avoided by using Decision Based Unsymmetric Trimmed Median Filter (DBUTMF) [6]. This method doesn't results for noise density greater than 80%. To avoid this problem a Modified Decision Based Unsymmetric Trimmed Median Filter (MDBUTMF) [7-9] method is proposed. This method doesn't provide better visual and quantitative fidelity. The proposed Advanced Modified Decision Based Unsymmetric Trimmed Median Filter (AMDBUTMF) method provides better visual quality and gives reduced Mean Square Error (MSE) and better Peak Signal-to-Noise Ratio (PSNR) values than existing methods.

III. MEDIAN FILTER

In signal processing, it is often desirable to be able to perform some kind of noise reduction on an image or signal. The median filter is a nonlinear digital filtering technique, often used to remove noise. Such noise reduction is a typical pre-processing step to improve the results of later processing (for example, edge detection on an image). Median filtering is very widely used in digital image processing because, under certain conditions, it preserves edges while removing noise.

The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal. For 1D signals, the most obvious window is just the first few preceding and following entries, whereas for 2D (or higher-dimensional) signals such as images, more complex window patterns are possible (such as "box" or "cross" patterns). Note that if the window has an odd number of entries, then the median is simple to define: it is just the middle value after all the entries in the window are sorted numerically. For an even number of entries, there is more than one possible median, see median for more details.

To demonstrate, using a window size of three with one entry immediately preceding and following each entry, a median filter will be applied to the following simple 1D signal:

x = [2 80 6 3]

So, the median filtered output signal y will be:

y[1] = Median[2 2 80] = 2

y[2] = Median[2 80 6] = Median[2 6 80] = 6

y[3] = Median[80 6 3] = Median[3 6 80] = 6

y[4] = Median[6 3 3] = Median[3 3 6] = 3

i.e. y = [2 6 6 3].

IV. MODIFIED DECISION BASED UN SYMMETRIC TRIMMED MEDIAN FILTER

The basic concept behind this filter is to reject the noisy pixel from the selected window size of 3x3 with a processing pixel Pij If Pij =O or 255 then p') is a corrupted pixel. If the selected window contains all O's and 255's, then the pixel p') is replaced with the mean element of the window. If the selected window does not contains all elements as O's and 255's, then eliminate O's and 255's from the selected window and find the median value of the remaining pixel elements. p') is replaced with the median value. This process is repeated for the entire image.

V. PROPOSED ALGORITHM

The proposed Advanced Modified Decision Based Unsymmetric Trimmed Median Filter (AMDBUTMF) first detects the noise from the corrupted image. The processing pixel is verified whether noisy or noise free. If the processing pixel value lies between minimum' l' to maximum '254', then it is a noise free pixel. If the processing pixel value is either 0 or 255, then it is a noisy pixel which is processed by AMDBUTMF. The algorithmic steps in this method are as follows.

Algorithm:

Step 1: Insert O's to the First Row, First Column and Last Row, Last Column of the image.
Step 2: Select a window of size 3 x3, and consider the Processing pixel is Pij in the window.
Step 3: Process the corrupted image: If the processing pixel value lies between 0< p') <255, then it is an uncorrupted pixel and its value is left unchanged.
Step 4: If P,) =O or 255, then p') is a corrupted pixel. The possible cases of processing the pixel:

> Case i): If the selected window contains all O's and 255's, then p') is replaced with mean of the elements in the window.
>
> Case ii): If all the elements in the selected window does not have O's and 255's, eliminate O's and 255's, sort in the ascending order and find the median value of the remaining elements. Replace Pij with the median value.

Step 5: Repeat steps 2 to 4 until all the pixels in the entire image is processed.
Step 6: Repeat steps 2 to 5.
Step 7: Remove additionally inserted Rows & Columns of O's in step 1.

VI. SIMULATION RESULTS

The proposed method has been simulated by using MATLAB. Results are very much evident that, proposed method has yielded better results compared to existing methods even under high noise densities. Proposed method is compared with other techniques by using the metrics such as PSNR & MSE. Proposed algorithm has been applied on both gray scale as well as colour images. But, the algorithm is efficient for gray scale image compared with colour image.

Fig 1: Input grey scale image

Fig 2: Noise added image

Fig 3: MDBUTMF (Existing Method)

Fig 4: Noise removed image (Proposed)

Figures 1 to 4 shows the original gray scale image, noisy image and noisy removed by using existing method and finally noisy removed by using proposed method.

Fig 5: Input colour scale image

Fig 6: Noise added image

Fig 7: Noise removed image

Figures 5 to 7 shows the original colour image, noisy image and noisy removed by using proposed method. Whereas, existing method is unable to remove the noise from colour image. Our proposed method is able to remove the noise from colour images also.

Table 1: Comparison Table for gray scale images for Existing and Proposed method of various noise densities

Noise Density	Gray scale Image(Existing method)		Gray Scale Image(Proposed method)	
	PSNR	MSE	PSNR	MSE
0.1	37.91	9.33	42.75	0.0000530
0.2	34.78	22.16	39.23	0.0001195
0.3	32.29	38.02	36.68	0.000214
0.4	30.32	59.19	34.77	0.0003335
0.5	28.18	90.28	32.32	0.000585
0.6	26.43	126.32	28.76	0.0013308
0.7	24.30	169.94	24.69	0.0033966
0.8	20.15	311.81	20.30	0.009330
0.9	15.40	446.68	15.97	0.025281

Table 2: Comparison Table for Colour images of various noise densities

Noise Density	Colour Image	
	PSNR	MSE
0.1	25.12	0.003074
0.2	23.55	0.004413
0.3	22.27	0.0060
0.4	21.07	0.007813
0.5	19.84	0.010372
0.6	18.46	0.014254
0.7	16.70	0.021404
0.8	14.31	0.037046
0.9	11.65	0.06837

Tables 1 and 2 shows the comparison tables for existing and proposed methods w.r.t to their PSNR and MSE.

Colour images

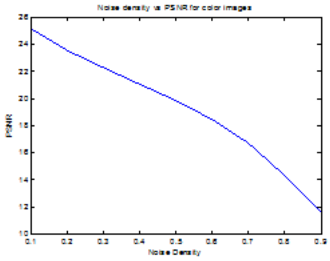

Figure 8: Comparison of noise density vs PSNR

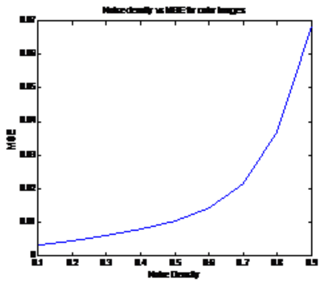

Figure 9: Comparison of noise density vs MSE

Gray scale images

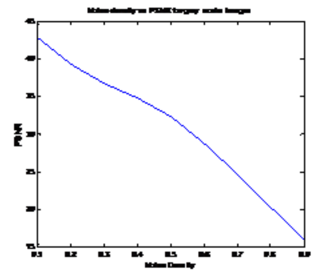

Figure 10: Comparison of noise density vs PSNR

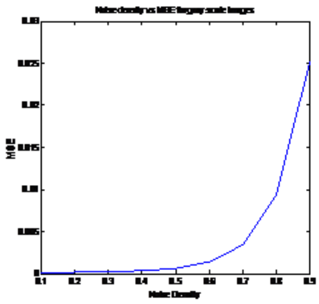

Figure 11: Comparison of noise density vs MSE

The comparison among existing and proposed methods with respect to PSNR and MSE is shown graphically in figure 8 to 11.

VII. CONCLUSION

In this paper, a new algorithm is proposed and compared with different de noising algorithms like median filter, adaptive median filter, progressive switched median filter, decision based algorithm, decision based unsymmetrical trimmed median filter, modified decision based unsymmetrical trimmed median filter. Simulation results clearly shows that the proposed method is much better in removing the noise with high density compared with the existing methods in terms of PSNR and MSE.

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N.Krishna Chaitanya is currently working as an Associate Professor in the department of ECE in PBR VITS and he has 14 years of teaching experience. He is presented and published 24 papers in International/ National Journals and International/ National conferences. He is member of ISTE and IEEE. He is reviewer and Editorial board member for various international journals.

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